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(54) Process for the temperature control of a drying apparatus for tabacco leaves.

(57) A process for controlling the temperature of a cut tobacco leaves drying apparatus including a cylindrical rotor having a plurality of heating means which are arrayed in an advance direction of raw material independently of each other is provided. The process comprises the steps of determining a temperature preset value to provide an optimum drying temperature at each section upon basis of the flow rate characteristics at the section, an operated value based upon the measure values of the flow rate and the moisture rate of the cut tobacco leaves and a given value preliminarily preset for the section; controlling the heating means in accordance with the preset value; and feedback controlling at least the last one of the heating means based upon the measured value of the moisture rate of the dried tobacco leaves discharged from the rotor. The preliminarily preset given value is a value for providing a final target value at each section of the rotor with a temperature gradient which is increased from the entrance to the exit of the rotor.

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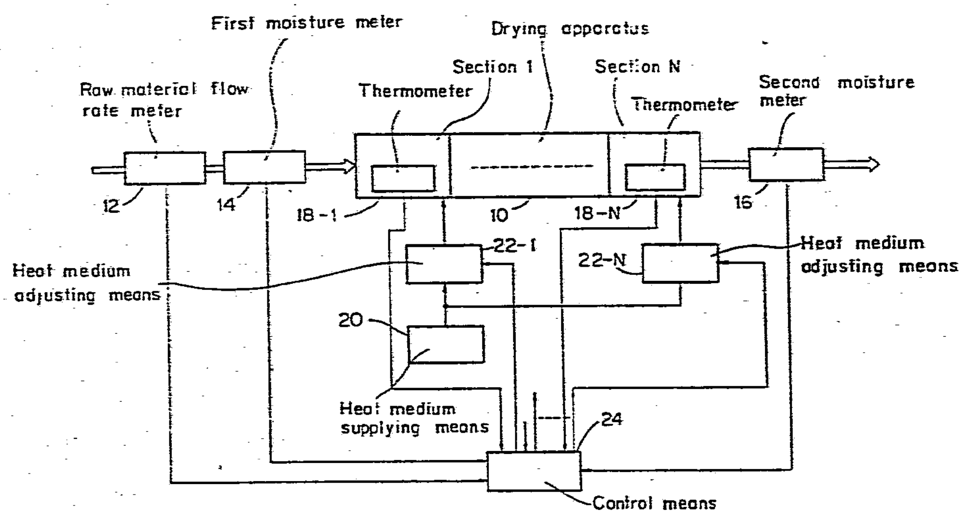
FIG. 1



First moisture meter
Drying apparatus
Section 1
Section N
Raw material flow rate meter
Thermometer
Thermometer
Second moisture meter
12
14
18-1
10
18-N
16
22-1
22-N
Heat medium adjusting means
Heat medium adjusting means
20
Heat medium supplying means
24
Control means

BACKGROUND OF THE INVENTION

The present invention relates to a process for temperature control, and in particular to a process for the temperature control of a drying apparatus in which cut tobacco leaves which have been charged into the entrance thereof are dried so that the moisture rate of the cut tobacco leaves kept constant and is discharged from the exit thereof.

When the cut tobacco leaves are dried, the finished product having an appointed uniform moisture rate is tried to be obtained. A period of time since the cut tobacco leaves are charged into the drying apparatus until the amount of the cut tobacco leaves held at each part of the drying apparatus is stabilized to a substantially constant state, that is, the flow rate of the cut tobacco leaves at the exit of the drying apparatus is stabilized is referred to as rise-up time or unsteady time, which is discriminated from the subsequent period referred to as stable time or steady time.

If similar temperature control is carried out during both periods, drying would be excessive at rise-up time and final product having a desired moisture rate could not be obtained. For example if the period of the rise-up time is 10 to 15 minutes in a drying apparatus into which cut tobacco leaves are supplied at a flow rate of 6000kg/h, there is a possiblity of production of 50 to 100kg of unqualified product.

Furthermore, since recent consumers' requirement for

the tobacco taste is high, it is necessary to provide high quality products as well as simply qualified products.

SUMMARY OF THE INVENTION

The present invention was made for overcoming the problem of the prior art. It is an object of the present invention to provide a process for controlling the temperature of a cut tobacco leaves drying apparatus, which is capable of causing the moisture rate due to drying at rise-up time to reach a target value as fast as possible and of providing cut tobacco leaves having excellent quality.

The object of the invention can be accomplished by providing a process for controlling the temperature of a cut tobacco leaves drying apparatus having a plurality of heating means which are arrayed in an advance direction of raw material independently of each other, said process comprising the steps of determining a temperature preset value to provide an optimum drying temperature at each section upon basis of the flow rate characteristics at the section, an operated value based upon the measure values of the flow rate and the moisture rate of the cut tobacco leaves and a given value preliminarily preset for the section; controlling the heating means in accordance with the preset value; and feedback controlling at least the last one of the heating means based upon the measured value of the moisture rate of the dried tobacco leaves discharged from the rotor, said preliminarily preset given value being a value for providing a final target value at each section of the rotor with a temperature gradient which is increased from the entrance to the exit of the rotor.

BREIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic block diagram showing a drying apparatus for carrying out a process of the present invention;

Fig. 2 is a block diagram showing an embodiment of control means shown in Fig. 1;

Fig. 3 is a schematic diagram illustrating an example of the drying apparatus;

Fig. 4 is a graph showing the change in flow rate of the cut tobacco leaves charged into the drying apparatus shown in Fig. 3;

Fig. 5 is a graph showing the change in flow rate at a given position of each section when the cut tobacco leaves charged at a flow rate shown in Fig. 4;

Fig. 6 is a graph showing the change in temperature at each section depending upon the change in flow rate of Fig. 5;

Fig. 7 is a graph showing a state in which final target value at respective section is provided with a difference in Fig. 6;

Fig. 8 is a graph showing the thermal response characteristics of each section;

Fig. 9 is an explanatory view showing the relation

of position of a flow rate meter and moisture meter with respect to the drying apparatus;

Fig. 10 is a graph showing preset temperature for changing the temperature of each section in accordance with the curve shown in Fig. 7;

Fig. 11 is a flow chart for carrying out the process of the present invention by means of a computer shown in Fig. 2; and

Fig. 12 is a graph for explaining the definition of control states.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The present invention will be described by way of embodiments with reference to the drawings.

Referring to Fig. 1, there is shown a schematic structure of the system for accomplishing a process of the present invention. Reference numeral 10 represents a drying apparatus comprising a cylindrical rotor having a plurality of heater means (not shown) which are independent of each other and arranged in cut tobacco leaves feeding direction. The rotor of the drying apparatus may be deemed as being divided into a plurality of drying sections 1 to N corresponding to respective heating means. Reference nemerals 12 and 14 represent cut tobacco leaves flow rate meter and a first moisture meter respectively. The flow rate meter 12 and the first moisture meter 14 are disposed

outside the entrance of the drying machines 10 for determining the flow rate and the moisture rate of the cut tobacco leaves charged into the drying apparatus 10. A second moisture meter 16 is disposed outside the exit of the drying apparatus 10 for determining the moisture rate of the cut tobacco leaves which has been dried by the drying apparatus 10. Thermometers 18-1 to 10-N are provided at the drying sections 1 to N for determining the temperature thereof. Reference numeral 20 represents means for supplying heat medium for the purpose of drying which means are connected with the heater means in each section of the drying apparatus. The heat medium is supplied in the form of steam in this embodiment. Heat medium adjusting means 22-1 to 22-N which are disposed between the heat medium supplying means 20 and the heater means in each section are adapted to adjust the supply of the heat medium to each heater means in the drying sections 1 to N from the heat medium supply means 20 under the control of the control means 24 which will be described hereinafter.

The heater means comprises heating pipes and the heat medium adjusting means 22-1 to 22-N comprises diaphragm valves if the steam is supplied as a heat medium as described above.

The cylindrical rotor which forms the drying apparatus is tilted so that the entrance is slightly higher. When the rotor is driven to rotate by means of rollers (not shown) the rotor serves to move the cut tobacco leaves which has been charged into the entrance thereof toward the exit and to dry the cut tobacco leaves into a given moisture rate and to discharge it from the exit.

The control means 24 comprises an electronic computor such as microcomputor. The control means 24 receives signals from the raw material flow rate meter 12, the first moisture meter 14, the second moisture meter 16 and the thermometers 18-1 to 18-N. The control means 24 controls the heat medium adjusting means 22-1 to 22-N by arithmetically processing the signals in accordance with a predetermined program. In other words, the control means 24 generates control signals for opening or closing the diaphragm valves. The outline of the structure will be described with reference to Fig. 2.

In Fig. 2 reference numeral 241 represents a central processing unit (hereinafter referred to as CPU) which carries out control of jobs which are executed in accordance with a program, arithmetic operation which necessary in the execution of jobs and control of other devices and management of reception and transmission of the data required for this control.

A memory device 242 comprises a read only memory 242a (hereinafter referred to as ROM) which stores a program for fixed jobs which the computor executes and a read and write memory 242b (hereinafter referred to as RAM) which stores constants required for program, operation results and input information.

A process input/output device 243 comprises a multiplexer 243a (hereinafter referred to as MX) which subsequently switches the analog input signals from the cut tobacco leaves flow rate meter 12, the first moisture meter 14, the second moisture meter 16 and the thermometers 22-1

to 22-N, an analog to digital convertor 243B (hereinafter referred to as A/D C) which converts the signals from the multiplexer 243a into analog signals which may be processed by the computor and digital to analog convertor 243C (hereinafter referred to as D/A C) which converts the digital information obtained by arithmetic processing in the computor into an analog output for actuating the diaphragm valves 22-1 to 22-N.

An input/output device 244 comprises a serial interface 244a which provides video information and input data to a CRT display 26 and receives and feeds the data from and to the computor when the data is printed out by a printer 27 and a keyboard input device 244b which transforms the data from a keyboard 28 operated for storing constants by an operator and transmits them to CPC 241.

Reference numeral 245 represents an data bus through which various data are received and fed among the aforementioned devices.

The temperature control by the control device 24 will be described in detail with reference to Fig. 3 and the following figures.

When flow rate of the cut tobacco leaves at the entrance rises up to F_0 as shown in Fig. 4 in the drying apparatus 10 which are divided into four drying sections 1 to 4 as shown in Fig. 3, the flow rates F_1, F_2, F_3 and F_4 at each drying section on cut tobacco leaves charging change as shown in Fig. 5.

In Fig. 5, L_1, L_2 and L_3 represent the time it takes for the cut tobacco leaves to pass the length between the drying apparatus entrance and the section 2, the length between the drying apparatus entrance and the section 3 and the length between the drying apparatus entrance and the section 4 respectively. Ts represents a time until the flow rate at each section reaches at the steady flow rate F_0 which is referred to as setting time. The flow rate curves F_1, F_2, F_3 and F_4 are approximated by omitting L_1, L_2 and L_3 as follows;

$$Fi(s) = \frac{F_0}{(1+T\alpha i \cdot s)\cdot s} \qquad \ldots\ldots (1)$$

In the formula, <u>i</u> represents 1 to 4, $T\alpha i$ represents flow rate characteristics constant and <u>s</u> a Laplacian operator. The temperature T_{A0} at each section for making the moisture at the exit of the driving apparatus to a constant value under the condition at which F_1 to F_4 reach at a constant flow rate F_0 after the passage of the period T_s may be represented as follows;

$$T_{A0} = \alpha \cdot F_0 + \beta \cdot \omega_1 - \delta \qquad \ldots\ldots (2)$$

wherein ω_1 represents a moisture rate of the raw material which is obtained from the first moisture meter 14 in Fig. 1. The constant flow rate F_0 is obtained by the cut tobacco leaves flow rate meter 12. α, β and δ represent operation parameters.

If the temperature at each section immediately before charging of the cut tobacco leaves is assumed as T_0, a target moisture rate may be obtained at the exit of the

drying apparatus immediately after rise-up of the raw material by raising the temperature at each section to T_{A0} represented by the formula (2) by drawing the curves in Fig. 6 which are similar to those in Fig. 5.

If the optimum drying temperature curve $T_{Ai}(t)$ until reaching at T_{A0} at each section is deemed as $\Delta T_{Ai}(s)$ by omitting L_1, L_2 and L_3, the $\Delta T_{Ai}(s)$ is represented as follows;

$$\Delta T_{Ai}(s) = \mathcal{L}\{T_{Ai}(t) - T_0\}$$

$$= \frac{T_{A0} - T_0}{(1 + T\alpha i \cdot s) \cdot s} \quad \ldots\ldots (3)$$

wherein $\mathcal{L}$ represents a Laplacian transformation operation.

By the way, there has been a finding that provision of temperature with a gradient is more desirable than maintaining a constant temperature at each section from the point of quality in order to carry out the temprature control at each section under a steady condition of the drying machine. Accordingly, all the final temperature at rise-up time in each section are not made T_{A0}. For example, Temperatures $T_{A0} + \Delta T_1$, T_{A0} and $T_{A0} + \Delta T_2$ are set at sectionl, 2 and 3 respectively so that a negative gradient is provided toward the exit.

By accomplishing the temperature control in such a manner, the characteristics shown in Fig. 6 is changed to that of Fig. 7. The above-identified formula (3) is changed as follows;

$$\Delta T_{A1}(s) = \frac{T_{A0} + \Delta T_1 - T_0}{(1 + T\alpha_1 \cdot s) \cdot s}$$

$$\Delta T_{A2}(s) = \frac{T_{A0} - T_0}{(1 + T\alpha_2 \cdot s) \cdot s}$$

$$\Delta T_{A3}(s) = \frac{T_{A0} + \Delta T_2 - T_0}{(1 + T\alpha_3 \cdot s) \cdot s}$$

$$\Delta T_{A4}(s) = \frac{T_{A0} - T_0}{(1 + T\alpha_4 \cdot s) \cdot s} \qquad \ldots\ldots (3)$$

The temperature response curves at each section change as shown in Fig. 8 when the target value of the temperature at each drying section is stepwise changed. If the target value, thermal transfer characteristics of temperature response among sections and the temperature of the section are represented as $T_{sv}(s)$, $G(s)$ and $T_A(s)$ respectively by using Laplacian operator the following relation is established.

$$G(s) = \frac{T_A(s)}{T_{sv}(s)} \qquad \ldots\ldots (4)$$

The transfer characteristics $G_i(s)$ of each section is represented from the Fig. 8 as follows:

$$G_i(s) = \frac{1}{1 + T\beta i \cdot s} \qquad \ldots\ldots (5)$$

wherein $T\beta i$ represents a constant of the thermal response characteristics at each sections. Dead time is omitted from the formula (5).

From the formulae (3) to (5) the preset temperature

T*SETi for providing the optimum drying temperature T_A at each drying section is represented by the formulae (6), (7) and (8).

$$T^*SETi = Tsvi \qquad \ldots\ldots (6)$$

$$T_{A0} = \alpha \cdot F_0 + \beta\omega_1 - \delta \qquad \ldots\ldots (7)$$

$$T^*SET_1 = T_{A0} + \Delta T_1 - \frac{(T_{A0} + \Delta T_1 - T_0)\ (T\alpha_1 - T\beta_1)}{T\alpha_1} \cdot \exp^{(-t/T\alpha_1)}$$

$$T^*SET_2 = T_{A0} - \frac{(T_{A0} - T_0)\ (T\alpha_2 - T\beta_2)}{T\alpha_2} \cdot \exp^{(-t/T\alpha_2)}$$

$$T^*SET_3 = T_{A0} + \Delta T_2 - \frac{(T_{A0} + \Delta T_2 - T_0)\ (T\alpha_3 - T\beta_3)}{T\alpha_3} \cdot \exp^{(-t/T\alpha_3)}$$

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$$T^*SET_4 = T_{A0} - \frac{(T_{A0} - T_0)\ (T\alpha_4 - T\beta_4)}{T\alpha_4} \cdot \exp^{(-t/T\alpha_4)} \quad \ldots\ldots (8)$$

The formula (8) may be obtained by reverse-transforming $T_{sv}(s)$ which is obtained by putting the above formulae (3) and (5) into the formula (4).

Since the raw material flow rate meter 12 which is disposed together with the first moisture meter 14 at the entrance side of the drying apparatus is positioned upstream of the entrance by a length L* as shown in Fig. 9, it takes time for the raw material detected by the flow rate meter 12 to reach the exit of the drying apparatus. The length L* corresponding to this time is known. Accordingly, a bias temperature T_{c1} is preliminarily preset at an interval t_0 to t_1 as shown in Fig. 10 before the reaching of the cut tobacco leaves in order to raise the temperature of the drying section 1 at the time then the raw material reaches at the entrance of the drying apparatus 10 by correcting the thermal response dead time T in rise-up of the temperature at the drying section, which has been described hereinabove with reference to Fig. 10. As similarly, bias temperatures T_{c2}, T_{c3} and T_{c4} are preliminarily preset between intervals t_2 to t_3, t_4 to t_5, and t_6 to t_7 with respect to the sections 2 to 4 respectively.

In connection with the sections 1 to 3, preset

temperature T^*SET_1, T^*SET_2 and T^*SET_3 which are obtained by the above-mentioned formula (8) are preset for the intervals t_1 to t_9, t_3 to t_9, and t_5 to t_9 respectively in Fig. 10. A preset temperature T^*SET_4 by the formula (8) is preset only the interval t_7 to t_8 in connection with the section 4. Other temperature presetting is accomplished for the time T_8 and following time.

In operation the moisture rate of the dried cut tobacco leaves is sequentially measured by the second moisture meter 16 at the output side of the drying apparatus 10. The drying temperature is controlled so that the measured signal ω_2 becomes a target moisture rate ω^*. Such control is a feedback control. Since the control is carried out while measuring a true moisture rate, the target moisture rate may be assured.

Since the temperature presetting at each section depends upon the forecast method in which a target moisture rate may be obtained upon basis of a model formula in which the flow rate time constant characteristics and then thermal response characteristics etc. are approximated. The errors in the model formula and other disturberance are of course involved so that there is possibility that the moisture rate of the dried raw material becomes a target moisture rate. It is therefore an object of such control to correct the errors.

Temperature T_{A0} is preset after a time t_9 in accordance with the formula (2) in connection with the sections 1 to 3. This control is carried out in a steady state and referred to as feed forward control. Feed back control is

continued in the section 4.

Since the actual temperature adjustment is carried out by opening and closing the diaphragm valves even if the temperature is preset by the afore-mentioned preset temperature T^*SET_1 to T^*SET_4, a valve opening signal m_i is obtained by carrying out the adjustment operation of the following formula (9), that is, proportion, integration and differential (PID) operation

$$m_i = K_{pi}\{(Tsvi - Ti) + \frac{1}{T_{Ii}}\int_0^t (Tsvi - Ti)\, dt + T_D i \frac{(Tsvi - Ti)}{dt}\} \quad \ldots\ldots (9)$$

wherein K_p, T_1 and T_0 represent operation parameters referred to as proportional gain, differential time and integration time respectively and T_i represents temperature measuring signals from the thermometers 18-1 to 18-4. For the feed back control period, a target temperature signal m_5 of the heating pipe corresponding to the section 4 is obtained by the PID operation of a following formula (10).

$$m_5 = K_{p5}\ \{(\omega^* - \omega_2) + \frac{1}{T_{I5}}\int(\omega^* - \omega_2)\, dt + T_{D5}\frac{d(\omega^* - \omega_2)}{dt}\} \quad \ldots\ldots (10)$$

The vavles corresponding to the sections 1 to 4 is opened or closed at an opening which is obtained by the above formula (9) and the valve corresponding to the section 4 is opened or closed at an opening obtained in

accordance with the formula (9) by a cascade control in which Tsv_i is preset by a target temperature signal obtained by the above formula (10). By doing so, the moisture rate at the rise-up of the cut tobacco leaves may be quickly changed to a target value soon.

The constants $T\alpha_1$, $T\alpha_2$, $T\alpha_3$ and $T\alpha_4$ of the flow rate characteristics are determined by assumption of the results of a fundamental experiment upon basis of the constant $T\alpha_4$ of the flow rate characteristics F_4 of Fig. 5. In practice, $T\alpha_1$, $T\alpha_2$ and $T\alpha_3$ are obtained by multiplying $T\alpha_4$ with a factor.

If the temperature T_0 of the drying apparatus just before the cut tobacco leaves are charged into the drying machine is various depending upon the working begining time and the environmental conditions, the condition becomes complicated and it is difficult to provide a good reproduction for controlling the moisture rate on cut tobacco leaves charging.

Fig. 11 is a flow chart showing a program for the afore-mentioned control which the control means 24 executes.

When the program is started in response to the detection of the cut tobacco leaves by the flow rate meter 12 in the shown chart, the heating means No. is set to 1 at step S1. That is, this setting appoints the control corresponding to the section 1. Following this, data are read out by adressing the RAM (represented as 242b in Fig. 2) which stores the constants relating to the control of the heating means No. 1 at step S2. The program then

goes to step 3 at which it determines what control state is.

The control state used herein includes three controls I to III which begin with the detection of the cut tobacco leaves as shown in Fig. 12. The term T_R until a bias temperature T_{ci} is preset since the detection of the cut tobacco leaves is defined as state I. A bias temperature preset term T_s to T_R is defined as state II and a term after the completion of the state II is defined as state III. Since the determination at step S3 just after start is state I, the program then proceeds to step S4. At step S4, it is determined whether or not the time after start is larger than T_R. The time T_1 is represented by the content of the counter which counts 1 per one second since the detection of the cut tobacco leaves.

Since the time is just after the program start, of course, $T_1 < T_R$. The result of determination is no and the program goes to step S5.

The temperature preset value T*SET is set to 0 at step S5. The program then goes to step S6 at which the heating means No. is added with 1 so that the heating means No is changed to 2. It is determined whether or not the heating means No is larger than 5 at next step S7. Since the result of determination is no, the program returns to step S2. Data is read out by addressing the RAM which stores the constatns relating to the control of the heating means No. 2 at step S2. The program goes to step S6 through the steps S3, S4 and S5. The heating means No. is changed to 3 at step S6. The program then

goes to step S6 again through the steps S7, S2, S3, S4 and S5. The heating means No. is changed to 4 at step S6. The program returns to step S6 again through steps S7, S2, S3, S4 and S5. The heating means No. is changed to 5. The program goes to step S7. The result of the determination at step S7 is yes, the program returns to start. However the restart is waited until one second has passed since the previous start.

The program is restarted after the passage of one second and goes to step S7 through the afore-mentioned steps S1, S2, S3, S4, S5 and S6. The jobs of steps S2 to S6 are repeated as is similar to afore-mentioned case until the heating means No. becomes 5. When the heating means No. becomes 5 the program returns to start.

If the T_{R1} of the heating means No. 1 is assumed to be 8 seconds the above-mentioned jobs would repeat 8 times. When the determination at step S4 is yes, the program goes to step S8. The control state of heating means No. 1 is set to state II. Then the program goes to step S6 at which the heating means No. is set to 2. Thereafter the program goes to step S4 through steps S2 and S3.

Even if the heating No. 1 is 8, the determination at step S4 is No since the T_R of the heating means No. 2, No. 3 and No. 4 is the times which are added with L_1, L_2 and L_3 (refer to Fig. 9) respectively. Thereafter the heating means No. is 5 and the jobs are excuted via steps S4, S5 etc. until the program is restarted.

The program is then restarted and the heating means No. is set to 1 at step S1. The determination on the control state is carried out at next step S2. Since the result of determination is started II, the program will go to step S9 at which determination whether $T1 \geqq T_S$ or not is carried out. Since the determination result is NO, the temperature preset value T^*SET_1 is set to a bias temperature T_c at next step S10.

Thereafter the heating means No. is set to 2 at step S6. The program will return to step S6 through steps S7, S2, S3, S4 and S5 until the heating means No. is changed to 5. If the determination results is yes at next step 7, the program will return to start.

Until the period T_s has passed, loop job is carried out via the steps S1, S2, S3, S9, S10, S6 and S7 as to the heating means No. and the loop job is carried out via the steps S2, S3, S4, S5, S6 and S7 as to the heating means Nos. 2, 3 and 4.

If the period T_s has passed, the determination result would be No at step S9 and the program will go to step S11 at which the control state of the heating means No. 1 is set to state III. Thereafter the program will go to step S12 at which initialization of RAM which stores data is carried out so that the data on the cut tobacco leaves flow rate F_0 and the moisture rate ω_1 collected before by a dead time T_s become initial data for control. Then the program will go to the step S7 via the step S6. The loop job of steps S2 to S7 as to heating means Nos. 2 to 4 until the heating means NO. becomes 5. When the heating means

No. becomes 5, the program will return to START.

The heating means NO. is set to 1 at step S1 again. The program will then go to step S3 via step S2. Determination on control state is carried out at step S2. Since the determination result is state III, the program will go to step 13 at which feed forward operation shown in the formula (2) is carried out upon basis of the data which have been initialized at the step 12 and constants so that the final desired or target value T_{A0} is calculated. The program then goes to step 14 at which pattern operation shown in the formula (8) is carried out so that T^*SET_1 is set. The preset temperature T*SET at time t=0 corresponds to T in Fig. 11. The program will go to step S7 via step S6 after the operation at step S14.

Following heating means Nos. 2 to 4 will be described. As apparent from Fig. 10, jobs of steps S2 to S7 are sequentially carried out as described above since the control of the heating means Nos. 2 to 4 is still in state I when the control of the heating means No. 1 is rendered into state III. The heating means Nos. 1, 2 and 3 are rendered into states II and III after periods of time L_1, L_2 and L_3 (Fig. 10) have passed since the heating means No. 1 is rendered into states II and III.

Steps S15 to S17 represented by dotted line in Fig. 11 are provided for carrying out feed back control of the heating means No. 4. Determination whether or not the heating means NO. is equal to 4 is carried out at step S15. Determination whether or not $T_1 \geqq T_B$ at step S16

wherein T_B is a time when feed back control begins. Feed back control is accomplished at step S17.

When the process of the present invention is carried out at a cut tobacco leaves drying apparatus under conditions of 12.5% wB of target moisture rate at the exit and not higher than 11.5% wB of abnormal moisture rate, the cut tobacco having an abnormal moisture rate can be suppressed to a remarkably low yield as 5kg at a total amount at 6000kg/h of flow rate of the raw material. Furthermore the control of moisture rate may be stably carried out.

Although feed back control is carried out at only final section in the above-mentioned embodiment, the same effect may be obtained by carrying out feed back control at other desired sections.

In accordance with the above-mentioned process of present invention the temperature of the drying apparatus when the cut tobacco leaves is charged into the drying apparatus is controlled according to the cut tobacco leaves flow range characteristics and the compensation for the thermal response dead time by application of bias temperature and feed back control based on the moisture rate of the dried tobacco is carried out.

The final target temperature at each section is provided with a temperature gradient increasing from the entrance to the exit of the rotor.. Therefore the production of unqualified product may be minimized by changing the moisture rate of the dried product at the rise-up time

of drying operation of the drying apparatus to a target value as soon as possible and the cut tobacco leaves the taste of which is acceptable may be obtained.

What is claimed is:

1. A process for controlling the temperature of a cut tobacco leaves drying apparatus including a cylindrical rotor having a plurality of heating means which are arrayed in an advance direction of row material independently of each other, said process comprising the steps of determining a temperature preset value to provide an optimum drying temperature at each section upon basis of the flow rate characteristics at the section, an operated value based upon the measure values of the flow rate and the moisture rate of the cut tobacco leaves and a given value preliminarily preset for the section; controlling the heating means in accordance with the preset value; and feedback controlling at least the last one of the heating means based upon the measured value of the moisture rate of the dried tobacco leaves discharged from the rotor, said preliminarily preset given value being a value for providing a final target value at each section of the rotor with a temperature gradient which is increased from the entrance to the exit of the rotor.

2. A process according to claim 1, wherein said process further comprises a step of applying a biasing temperature, prior to said temperature preset valve determining step, for compensating for thermal response dead time at the sections in the cylindrical rotor corresponding to respective heating means at a given time prior to the charging of the cut tobacco leaves.

FIG. 1

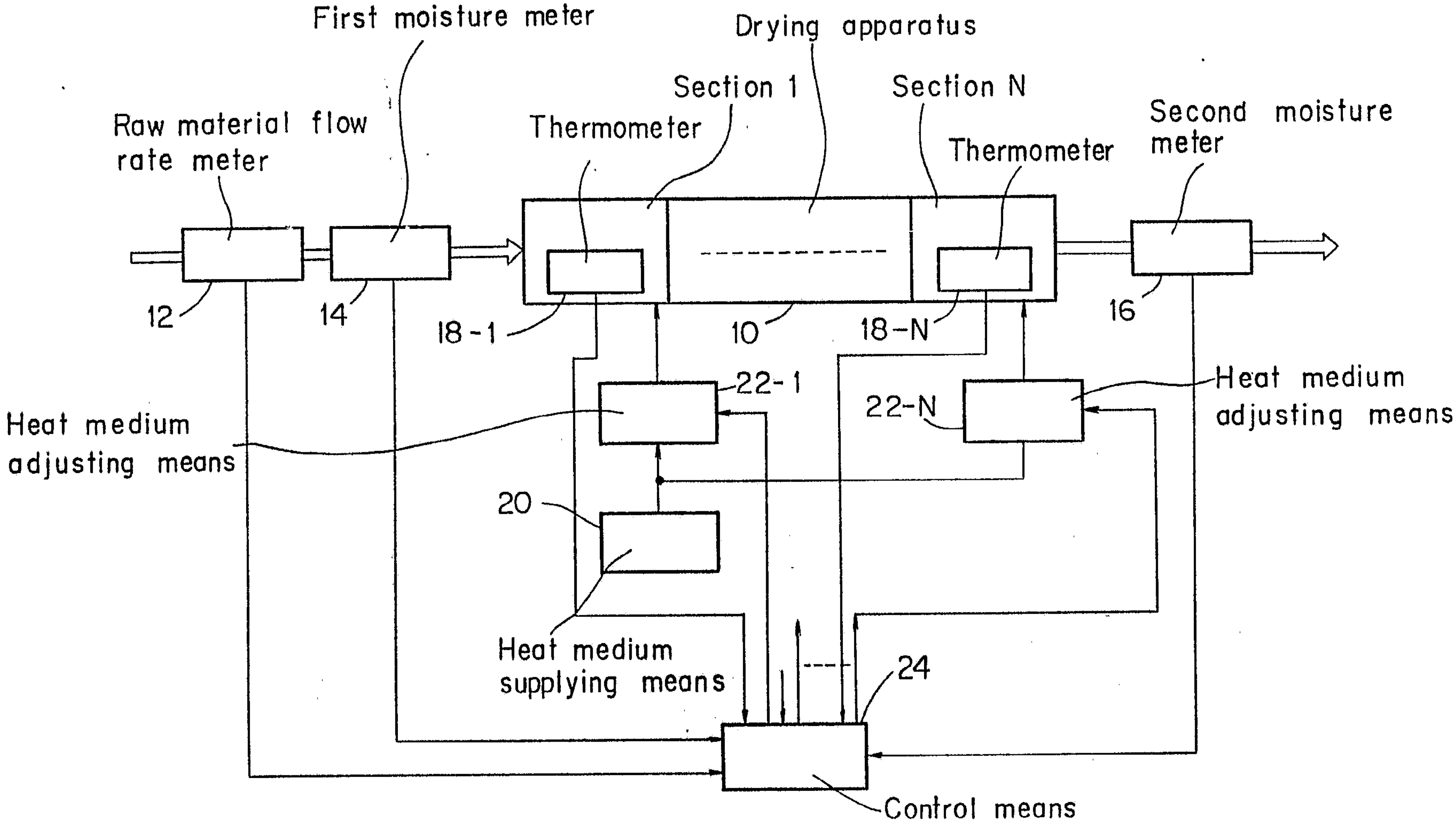

First moisture meter
Drying apparatus
Section 1
Section N
Raw material flow rate meter
Thermometer
Thermometer
Second moisture meter
12
14
18-1
10
18-N
16
22-1
22-N
Heat medium adjusting means
Heat medium adjusting means
20
Heat medium supplying means
24
Control means

FIG. 2

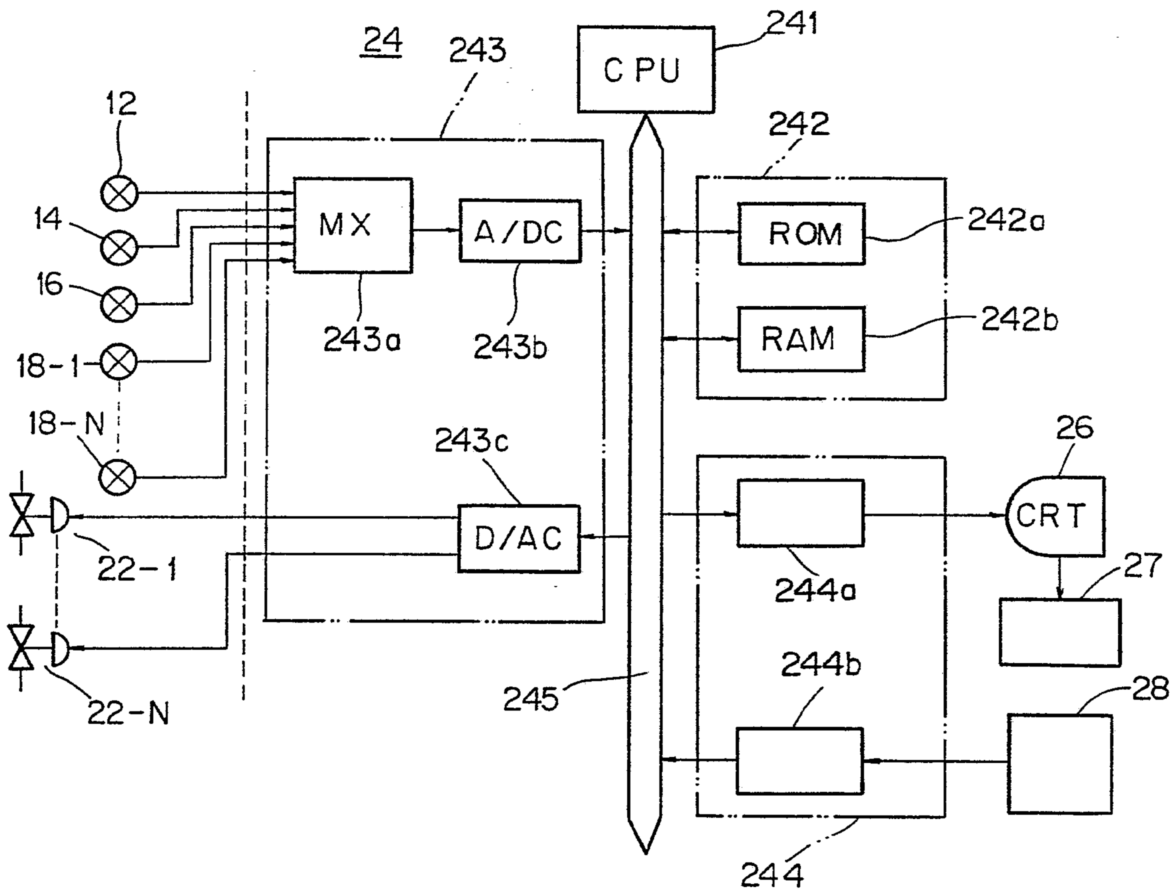

24
243
CPU
241
12
242
14
MX
A/DC
ROM
242a
16
243a
243b
RAM
242b
18-1
18-N
243c
26
D/AC
CRT
22-1
244a
27
244b
28
245
22-N
244

FIG. 3

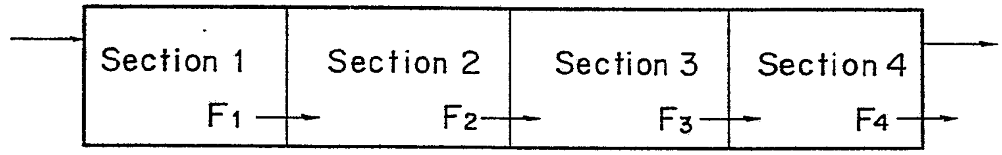

Section 1
Section 2
Section 3
Section 4
F_1
F_2
F_3
F_4

FIG.4

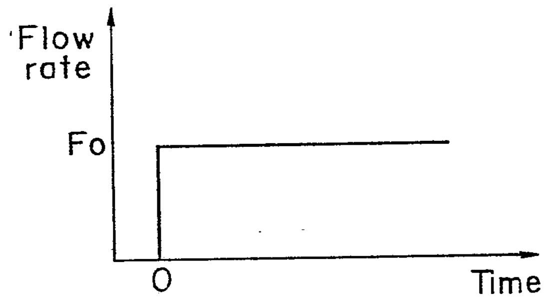


FIG.5

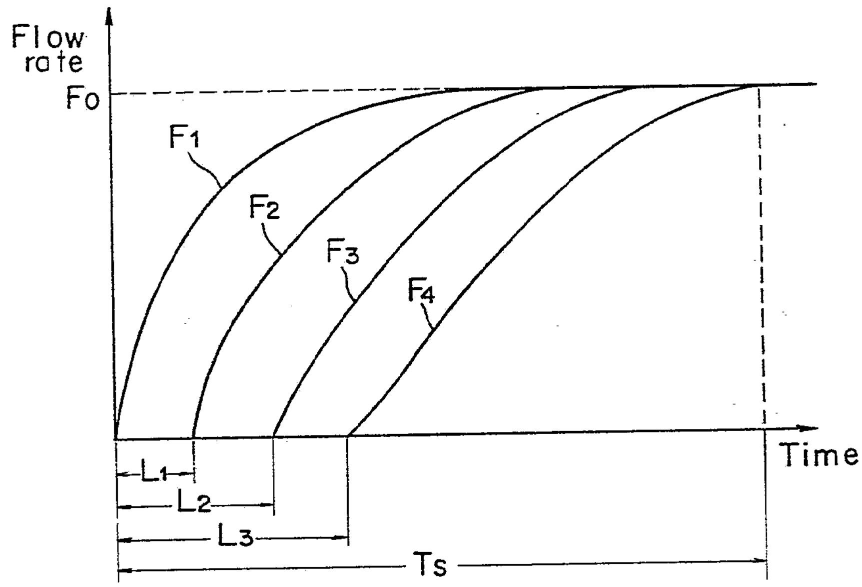


FIG.6

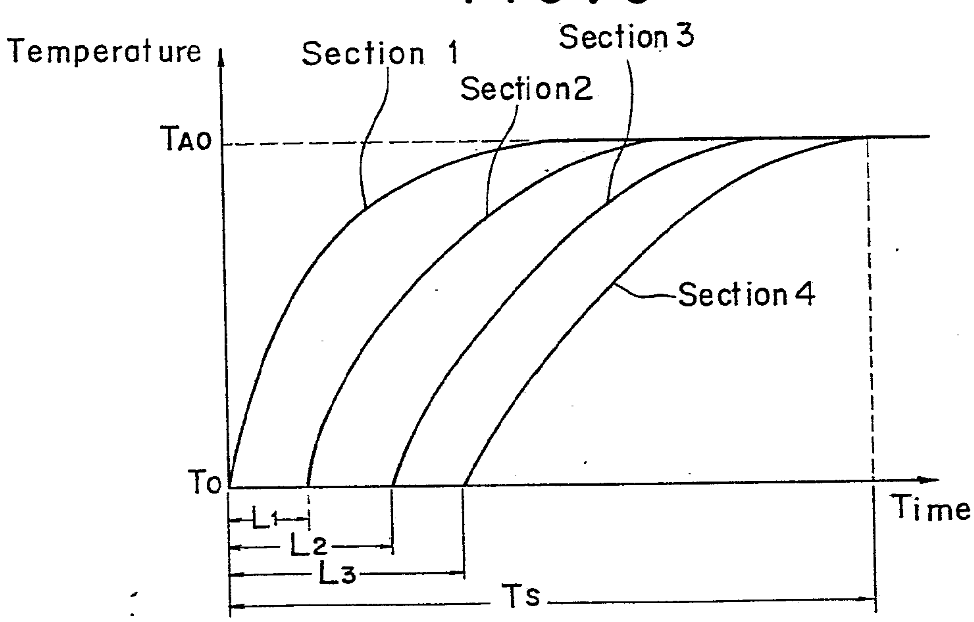


FIG. 7

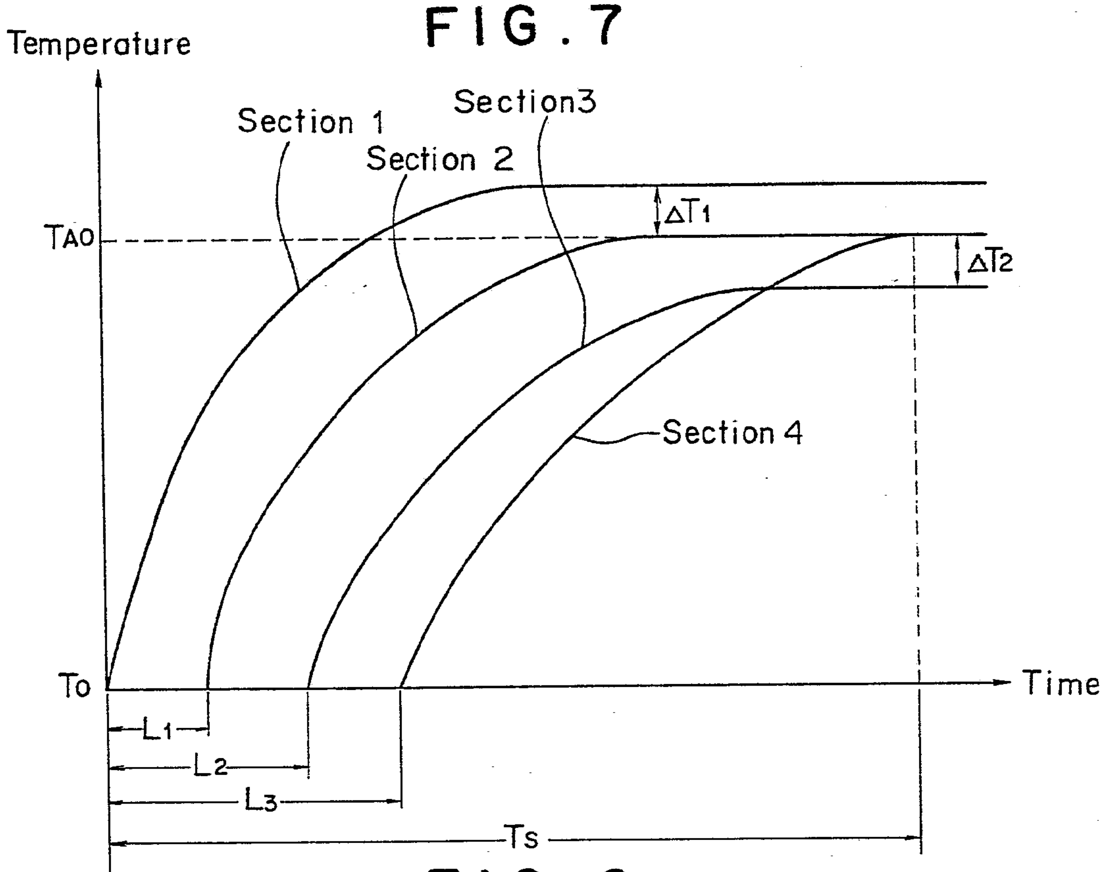


FIG. 8

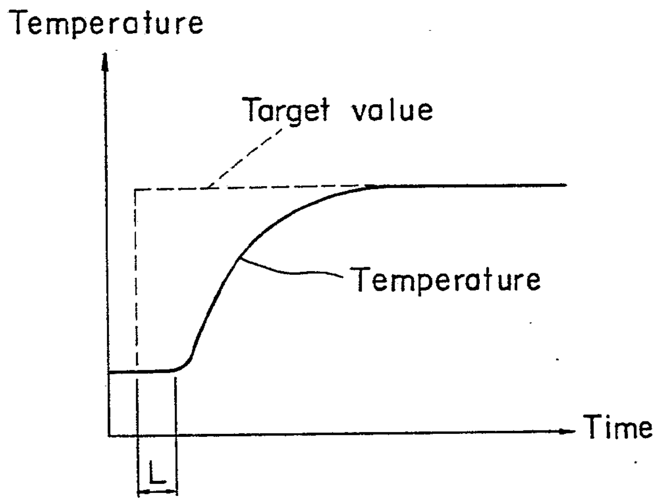


FIG. 9

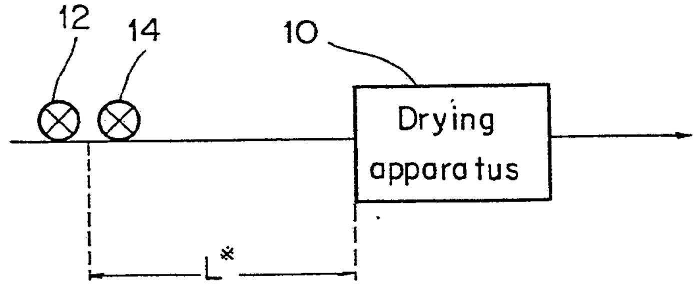


FIG.10

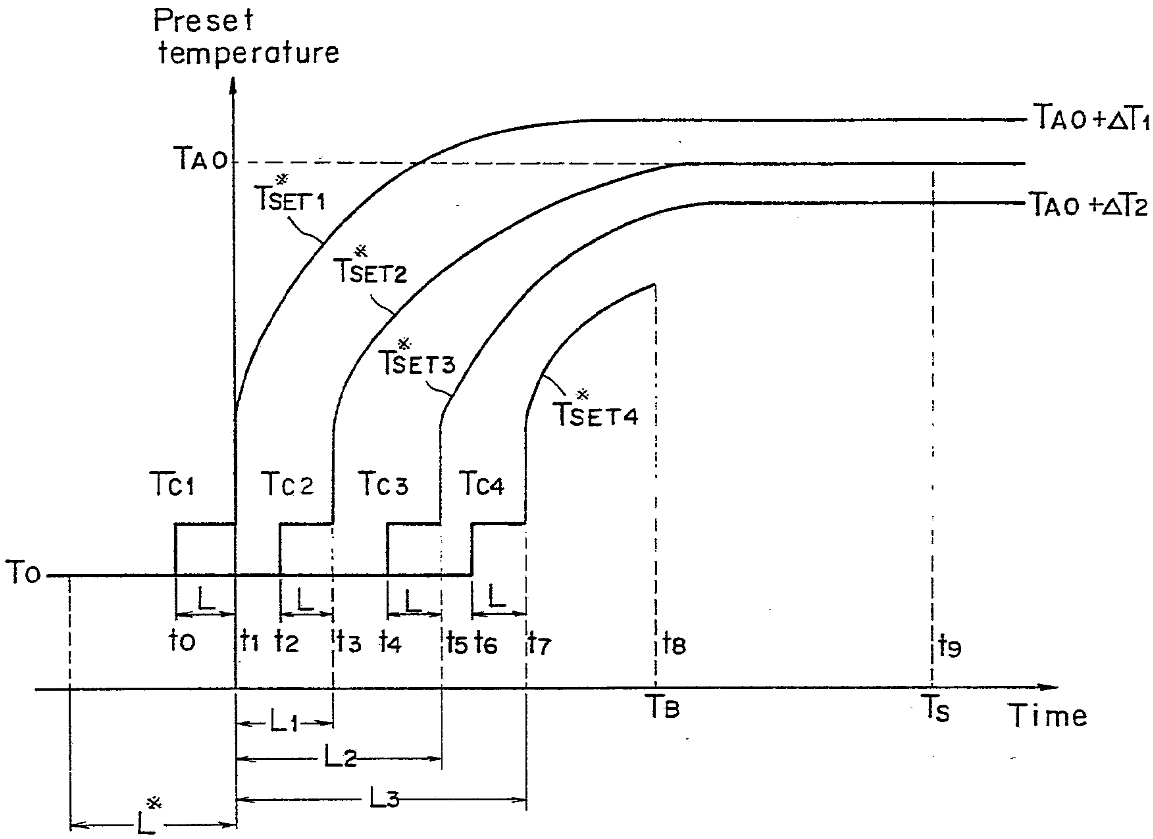

Preset temperature
TA0
TA0+ΔT1
TA0+ΔT2
T*SET1
T*SET2
T*SET3
T*SET4
Tc1
Tc2
Tc3
Tc4
To
L
L
L
L
to
t1
t2
t3
t4
t5
t6
t7
t8
t9
TB
Ts
Time
L1
L2
L3
L*

FIG.12

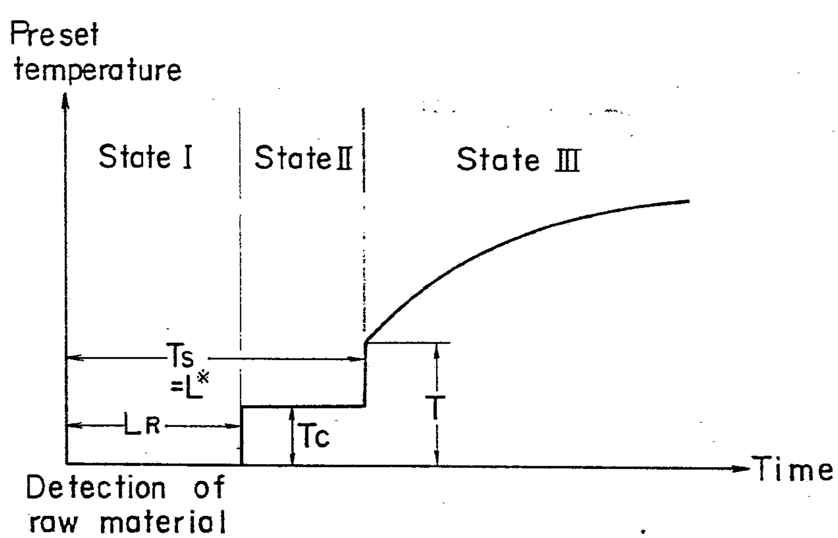
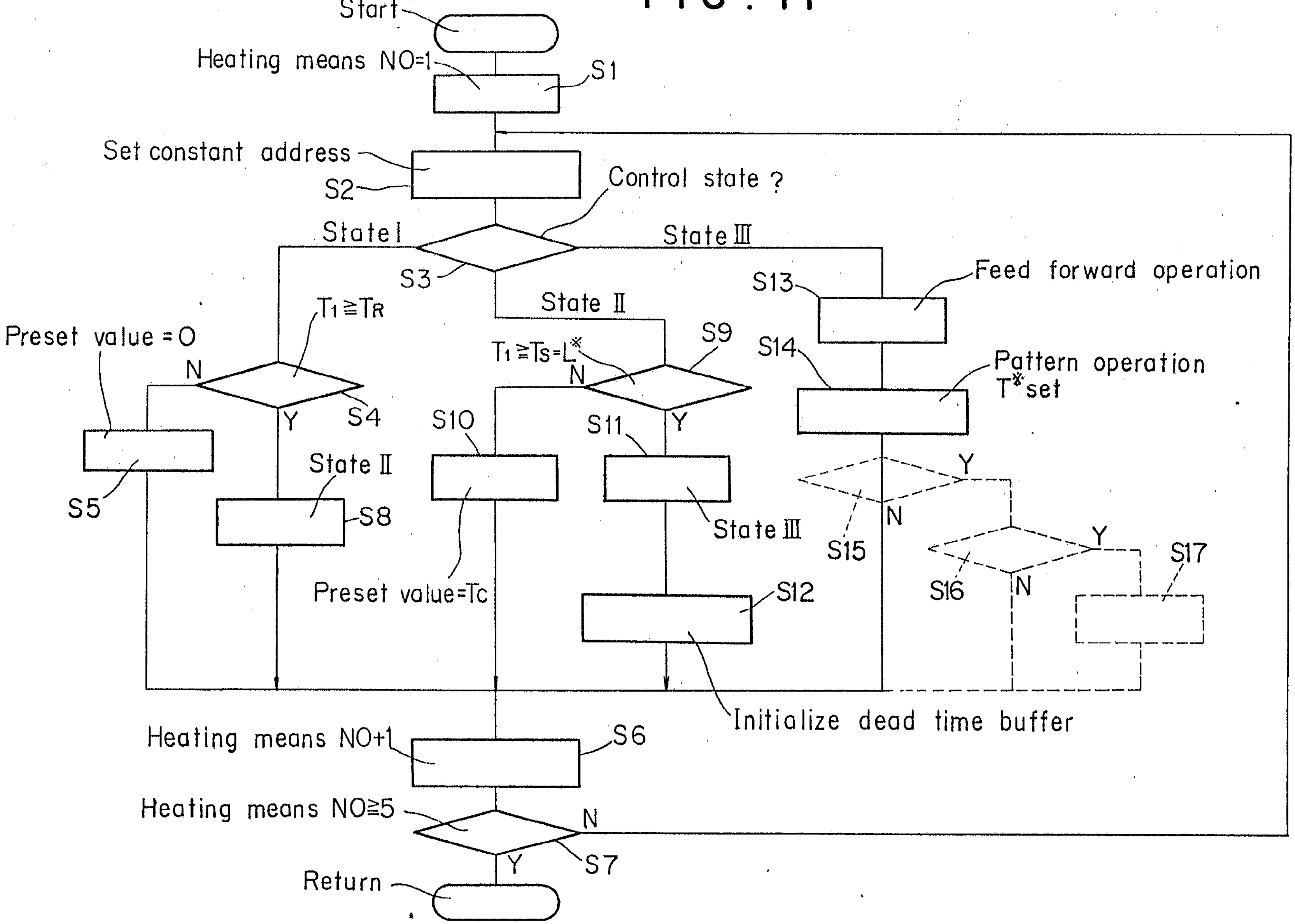

Preset temperature
State I
State II
State III
Ts =L*
LR
Tc
T
Time
Detection of raw material

FIG. 11


Start
Heating means NO=1
S1
Set constant address
S2
Control state ?
State I
S3
State III
S13
Feed forward operation
$T_1 \geqq T_R$
Preset value = O
N
Y
S4
S5
State II
S8
State II
S9
$T_1 \geqq T_S = L^*$
N
Y
S10
S11
Preset value=Tc
State III
S12
S14
Pattern operation
T^* set
Y
N
S15
Y
S16
N
S17
Initialize dead time buffer
Heating means NO+1
S6
Heating means NO≧5
N
Y
S7
Return